FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)
GRP-0003	09/868702

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DK99/00719	December 20, 1999	December 21, 1998

TITLE OF INVENTION
A COMMINICATION DEVICE

APPLICANT(S) FOR DO/EO/US
ION MARQVARDSEN, ET AL

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☒ is attached hereto (required only if not communicated by the International Bureau).
   b. ☐ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☒ Certificate of Mailing by Express Mail
23. ☐ Other items or information:

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Date of Deposit June 20, 2001
I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231.

Jennifer Mahon
(Typed or printed name of person mailing paper or fee)

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PCTUS1/REV03

JC18 Rec'd PCT/PTO 2 0 JUN 2001

ATION NO. (IF KNOWN, SEE 37 CFR	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/868702	PCT/DK99/00719	GRP-0003

The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
☐	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1000.00**	
☒	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**	
☐	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$710.00**	
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☐	International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**	
	ENTER APPROPRIATE BASIC FEE AMOUNT =	**$860.00**
	Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$0.00**

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	23 - 20 =	3	x $18.00	**$54.00**	
Independent claims	4 - 3 =	1	x $80.00	**$80.00**	
Multiple Dependent Claims **(check if applicable)**.			☐	**$0.00**	
	TOTAL OF ABOVE CALCULATIONS =			**$994.00**	
	Applicant claims small entity status. (See 37 CFR 1.27). The fees indicated above are reduced by 1/2.			**$0.00**	
	SUBTOTAL =			**$994.00**	
	Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +			**$0.00**	
	TOTAL NATIONAL FEE =			**$994.00**	
	Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐			**$0.00**	
	TOTAL FEES ENCLOSED =			**$994.00**	
				Amount to be: refunded	$
				charged	$

a. ☒ A check in the amount of **$994.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **06-1130** A duplicate copy of this sheet is enclosed.

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NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

CANTOR COLBURN LLP
55 Griffin Road South
Bloomfield, CT 06002
Telephone: 860-286-2929
Customer No. 23413

SIGNATURE

Daniel F. Drexler
NAME

47,535
REGISTRATION NUMBER

June 20, 2001
DATE

Express Mail Label #EL718784965US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF: ION MARQVARDSEN, ET AL.

FOR: A COMMUNICATION DEVICE

PRELIMINARY AMENDMENT

"Express Mail" mailing label number EL718784965
Date of Deposit June 20, 2001 6:50
I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231.
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Jennifer Matson
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BOX PCT
The Assistant Commissioner of
Patents and Trademarks
Washington, DC 20231

Dear Sirs:

Prior to the Examiner acting in the above-referenced application, please preliminary amend the claims as follows:

IN THE CLAIMS:

Please replace claims 1-19 with the following rewritten versions:

Claim 1. (Amended) Communication device comprising a housing enclosing at least one loudspeaker and at least part of at least one antenna inside the housing, said least one loudspeaker comprising an acoustic resonance chamber and said at least one antenna comprising at least one electromagnetic resonance chamber, wherein the acoustic resonance chamber is completely or partly located within the electromagnetic resonance chamber.

Claim 2. (Amended) Communication device according to claim 1, wherein the at least one antenna is a directive patch antenna.

Claim 3. (Amended) Communication device according to claim 1, wherein at least one antenna is a dual band antenna.

Claim 4. (Amended) Communication device according to claim 1, wherein the at least one antenna defines walls of the acoustic resonance chamber completely or partly.

Claim 5. (Amended) Communication device according to claim 1, wherein the loudspeaker is coupled with the resonance chamber by means of at least one acoustic channel.

Claim 6. (Amended) Communication device according to claim 1, wherein the at least one antenna is a coil or loop antenna.

Claim 7. (Amended) Communication device according to claim 1, wherein the acoustic resonance chamber is a pressure chamber.

Claim 8. (Amended) Communication device according to claim 1, wherein the acoustic resonance chamber has acoustic openings to an exterior.

Claim 9. (Amended) Communication device according to claim 1, wherein a dimension of the acoustic resonance chamber completely or partly located within the electromagnetic resonance chamber is 0.5 to 8 cm3.

Claim 10. (Amended) Communication device according to claim 1, wherein the shared resonance chamber is on an inside reinforced by reinforcement elements or walls dividing the chamber into smaller volumes.

Claim 11. (Amended) Communication device comprising a housing enclosing at least one loudspeaker and at least a part of at least one antenna inside the housing, said at least one loudspeaker comprising an acoustic resonance chamber and said at least one

antenna comprising at least one electromagnetic resonance chamber, wherein the acoustic resonance chamber is completely or partly located within the electromagnetic resonance chamber, wherein said loudspeaker and said acoustic resonance chamber are separated by means of at least one electromagnetic screen, said loudspeaker and said acoustic resonance chamber are acoustically connected through said electromagnetic screen by means of at least one acoustically coupling means.

Claim 12. (Amended) Communication device according to claim 11, wherein said screen is a ground plane of the antenna.

Claim 13. (Amended) Communication device according to claim 11, wherein the loudspeaker is coupled with the acoustic resonance chamber by means of at least one acoustic channel passing through said screen.

Claim 14. (Amended) Communication device according to claim 11, wherein the channel consists of one or more holes in said screen.

Claim 15. (Amended) Communication device according to claim 14, wherein a number of holes is between 1 and 50.

Claim 16. (Amended) Communication device according to claim 15, wherein a diameter of the one or more holes is between 0.5 and 5 mm.

Claim 17. (Amended) Communication device comprising a housing enclosing at least one loudspeaker and at least a part of at least one antenna inside the housing, said at least one loudspeaker comprising an acoustic resonance chamber and said at least one antenna comprising at least one electromagnetic resonance chamber, wherein the acoustic resonance chamber is completely or partly located within the electromagnetic resonance chamber and the acoustic resonance chamber or at least a main part of the acoustic resonance chamber is located at a distance from said loudspeaker.

Claim 18. (Amended) Communication device comprising a housing enclosing at least one loudspeaker and at least part of at least one antenna inside the housing, said at least one loudspeaker comprising an acoustic resonance chamber and said at least one antenna comprising at least one electromagnetic resonance chamber, wherein the acoustic resonance chamber is completely or partly located within the electromagnetic resonance chamber and the loudspeaker and the acoustic resonance chamber is connected by at least one acoustic coupling means.

Claim 19. (Amended) Communication device according to claim 17, wherein the acoustic coupling means is at least one acoustic channel.

Please add the following newly added claims:

Claim 20. (Newly Added) Communication device according to claim 6, wherein the coil or loop antenna is a directive coil or loop antenna.

Claim 21. (Newly Added) Communication device according to claim 15, wherein the number of holes is 4.

Claim 22. (Newly Added) Communication device according to claim 16, wherein the diameter of the one of more holes is 2mm.

Claim 23. (Newly Added) Communication device according to claim 18, wherein the acoustic coupling means is at least one acoustic channel.

REMARKS

Applicants request entry of the present amendments which conform the claims to U.S. practice. No new matter is being introduced by this Amendment as antecedent support is set forth in the original specification and in the original claims.

Prosecution on the merits is respectfully requested.

The Examiner is invited to contact Applicants' Attorneys at the below-listed telephone number regarding this Preliminary Amendment or otherwise regarding the present application.

If there are any charges with respect to this Amendment or otherwise, please charge them to Deposit Account No. 06-1130 maintained by Applicants' attorneys.

Respectfully submitted,

ION MARQVARDSEN, ET AL.

CANTOR COLBURN LLP
Applicants' Attorneys

By: _____
Daniel F. Drexler
Registration No. 47,535
Customer No. 23413

Date: June 20, 2001
Address: 55 Griffin Road South, Bloomfield, CT 06002
Telephone: 860-286-2929

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Claims 1-19 are amended herein as follows:

Claim 1. (Amended/Marked Up) Communication device comprising a housing enclosing at least one loudspeaker [(2)] and at least part of at least one antenna [(1)] inside the housing [(8)], said least one loudspeaker comprising an acoustic resonance chamber [(9)] and said at least one antenna comprising at least one electromagnetic resonance chamber [(13)], [characterised in that] wherein the acoustic resonance chamber [(9)] is completely or partly located within the electromagnetic resonance chamber [(13)].

Claim 2. (Amended/Marked Up) Communication device according to claim 1, [characterised in that] wherein the at least one antenna [(1)] is a directive patch antenna.

Claim 3. (Amended/Marked Up) Communication device according to claim 1 [or 2, characterised in that] wherein at least one antenna [(1)] is a dual band antenna.

Claim 4. (Amended/Marked Up) Communication device according to claim[s] 1[-3], [characterised in that] wherein the at least one antenna [(1)] defines [the] walls of the acoustic resonance chamber [(9)] completely or partly.

Claim 5. (Amended/Marked Up) Communication device according to claim[s] 1[-4], [characterised in that] wherein the loudspeaker [(2)] is coupled with the resonance chamber by means of at least one acoustic channel.

Claim 6. (Amended/Marked Up) Communication device according to claim[s] 1[-5], [characterised in that] wherein the at least one antenna [(1)] is a coil or loop antenna[, preferably a directive coil or loop antenna].

Claim 7. (Amended/Marked Up) Communication device according to claim[s] 1[-6], [characterised in that] wherein the acoustic resonance chamber [(9)] is a pressure chamber.

Claim 8. (Amended/Marked Up) Communication device according to claim[s] 1[-7], [characterised in that] wherein the acoustic resonance chamber [(9)] has acoustic openings to [the] an exterior.

Claim 9. (Amended/Marked Up) Communication device according to claim[s] 1[-8], [characterised in that] wherein a [the] dimension of the acoustic resonance chamber [(9)] completely or partly located within the electromagnetic resonance chamber is 0.5 to 8 cm3.

Claim 10. (Amended/Marked Up) Communication device according to claim[s] 1[-9], [characterised in that] wherein the shared resonance chamber is on [the] an inside [being] reinforced by reinforcement elements or walls dividing the chamber into smaller volumes.

Claim 11. (Amended/Marked Up) Communication device comprising a housing enclosing at least one loudspeaker [(2)] and at least a part of at least one antenna [(1)] inside the housing [(8)], said at least one loudspeaker [(2)] comprising an acoustic resonance chamber [(9)] and said at least one antenna comprising at least one electromagnetic resonance chamber [(13)], [characterised in that] wherein the acoustic resonance chamber [(9)] is completely or partly located within the electromagnetic resonance chamber [(13)], wherein said loudspeaker [(2)] and said acoustic resonance chamber [(9)] are separated by means of at least one electromagnetic screen [(11)], said loudspeaker and said acoustic resonance chamber are acoustically connected through said electromagnetic screen by means of at least one acoustically coupling means [(10)].

Claim 12. (Amended/Marked Up) Communication device according to claim 11, [characterised in that] wherein said screen is [the] a ground plane [(11)] of the antenna [(1)].

Claim 13. (Amended/Marked Up) Communication device according to claim 11, [characterised in that] wherein the loudspeaker [(2)] is coupled with the acoustic resonance chamber [(9)] by means of at least one acoustic channel [(10)] passing through said screen [(11)].

Claim 14. (Amended/Marked Up) Communication device according to claim 11, [characterised in that] wherein the channel [of] includes consists of one or more holes [(10)] in said screen [(11)].

Claim 15. (Amended/Marked Up) Communication device according to claim 14, [characterised in that] wherein [the] a number of holes is between 1 and 50[, preferably 4 holes].

Claim 16. (Amended/Marked Up) Communication device according to claim 15, [characterised in that] wherein [the] a diameter of the one or more holes is between [0,5] 0.5 and 5 mm[, preferably 2 mm].

Claim 17. (Amended/Marked Up) Communication device comprising a housing enclosing at least one loudspeaker [(2)] and at least a part of at least one antenna [(1)] inside the housing [(8)], said at least one loudspeaker comprising an acoustic resonance chamber [(9)] and said at least one antenna comprising at least one electromagnetic resonance chamber [(13)], [characterised in that] wherein the acoustic resonance chamber [(9)] is completely or partly located within the electromagnetic resonance chamber [(13)] and [that] the acoustic resonance chamber or at least [the] a main part of the acoustic resonance chamber is located at a distance from said loudspeaker [(2)].

Claim 18. (Amended/Marked Up) Communication device comprising a housing enclosing at least one loudspeaker [(2)] and at least part of at least one antenna [(1)] inside the housing [(8)], said at least one loudspeaker comprising an acoustic resonance chamber [(9)] and said at least one antenna comprising at least one electromagnetic resonance chamber [(13)], [characterised in that] wherein the acoustic resonance chamber [(9)] is completely or partly located within the electromagnetic resonance chamber [(13)] and [that] the loudspeaker and the acoustic resonance chamber is connected by at least one acoustic coupling means [(10)].

Claim 19. (Amended/Marked Up) Communication device according to claim 17 [or 18], [characterised in that] wherein the acoustic coupling means is at least one acoustic channel.

WO 00/38475

PCT/DK99/00719

A communication device

Field of the invention

The invention relates to a communication device comprising a housing enclosing at least one loudspeaker and at least a part of at least one antenna inside the housing, said at least one loudspeaker comprising an acoustic resonance chamber and said at least one antenna comprising at least one electromagnetic resonance chamber.

Background of the invention

Communication devices, such as handheld cellular phones, have gained widespread acceptance over the years. One reason for this is the constant development of new generations of communication devices of smaller dimensions than the previous ones making the communication device handier in use and more convenient to carry.

In the field of this invention, a conventional communication device comprises two volumes of interior space used as resonance chambers where the loudspeaker uses the first volume and the antenna uses the other volume.

A problem with the conventional communication device is to make it yet even smaller or at least maintain the size even though the communication device has to contain an

ever increasing amount of electronic components to be able to offer new features.

Summary of the invention

When, as stated in claim 1, the acoustic resonance chamber is completely or partly located within the electromagnetic resonance chamber, it is possible to manufacture considerably smaller communication devices than the conventional types with separate resonance chambers for the antenna and the loudspeaker.

At the same time, volume needed for walls to encapsulate two resonance chambers can now be reduced to walls surrounding the shared resonance chamber.

It should be noted that an acoustic resonance chamber according to the invention may e.g. be a closed pressure chamber or a partly closed bass reflection chamber adapted to obtain desired frequency characteristics and efficiency. The main component providing this feature in a pressure chamber loudspeaker is the air encapsulated by the walls defining the chamber and the membrane. The encapsulated air will accordingly act as an elasticity, defined within the art as c_m. Of course, a resonance chamber according to the invention can also comprise a bass reflection design in which especially the lower frequency of the loudspeaker system is modified by the adding of at least one opening from the internal of the loudspeaker chamber to the external.

The purpose of an acoustic resonance chamber is well described within the art of loudspeakers.

It should moreover be noted that an electromagnetic resonance chamber according to the invention is defined as at least part of the volume between at least a radiant part of an antenna and a ground plane or reference of said antenna. The said electromagnetic resonance volume has a specific dielectric constant and is arranged within the housing of the device.

It is understood that the electromagnetic resonance volume may comprise air or a combination of air and a dielectric material.

The meaning of an electromagnetic resonance chamber is well described within the art of antennas.

According to the teaching of the invention, the above resonance may be shared more or less extensively as the two different resonance phenomena may be established independently of each other. No interference or distortion will occur as the low frequency acoustic pressure wave resonance will be of a completely different nature than the electromagnetic resonance within the antenna resonance chamber.

Another important feature of the invention is that the desired electromagnetic performance of the antenna resonance chamber may be established fully or partly in air as the dielectric properties of air may fully satisfy the desired dielectric properties between e.g. the radiant plane and the ground plane of a patch antenna. Moreover, the desired conditions may be obtained by a combination of a solid dielectric and a gas dielectric,

i.e. air. This possibility of designing a dielectric resonance chamber as a combination of air and solid dielectric, or completely by air, results in a significantly increased freedom when designing the device. A solid dielectric according to the invention may e.g. be different kinds of plastics known within the art.

Due to the nature of the acoustic resonance chamber, the design of the internal shape of the chamber is of very little importance.

The communication device of the invention is preferably a mobile communication device or a handheld cellular phone.

Thus, according to the invention, the electromagnetic and the acoustic resonance chambers share a certain amount of air, having both the desired acoustic and dielectric properties.

Consequently, a reduction of weight and of course material expenses is obtained as the dielectric used to fill the volume inside the antenna may now be replaced by air.

When, as stated in claim 2, at least one antenna is a directive patch antenna, it is possible to control the direction of the radio waves from the antenna.

It should be noted that a directional patch antenna requires a relatively high resonance volume, i.e. resonance volume between the radiant part of the antenna and the ground plane, in order to obtain a satisfactory bandwidth. The possibility of establishing a shared

volume between the acoustic resonance chamber and the electromagnetic resonance space of the antenna provides the possibility of obtaining a significant reduction in volume. It should be noted that even an apparently minor reduction in volume of a communication device may be significant when an effective reduction in volume of e.g. 1 to 5 cm^3 is obtained in a 100 cm^3 mobile phone.

When, as stated in claim 3, at least one antenna is a dual-band antenna, it is possible to reduce the even stricter design criteria as the resonance volume will tend to occupy even more of the volume of the device.

When, as stated in claim 4, at least one antenna completely or partly defines the walls of the acoustic resonance chamber, it is possible to use the antenna for its main purpose while also letting it constitute part of the walls of the resonance chamber.

The antenna components such as ground plane and radiant plane may be supported by a great variety of chamber designs as the volume required for the acoustic resonance chamber will usually be significantly less than the required volume of e.g. a micro-strip antenna.

Of course, it should be kept in mind that the chamber defining materials, except for the active antenna planes, should have a dielectric constant being somewhat comparable with the air inside the chamber. At least, it should be designed in such a manner that the overall obtained dielectric properties meet the desired requirements.

When, as stated in claim 5, the loudspeaker is coupled with the acoustic resonance chamber by at least one acoustic channel, a further advantageous embodiment of the invention has been obtained.

When, as stated in claim 6, at least one antenna is a coil or loop antenna, preferably a directive coil or loop antenna, a further advantageous embodiment of the invention has been obtained.

When, as stated in claim 7, the acoustic resonance chamber is a pressure chamber, it is possible to let the loudspeaker use the air located within the acoustic resonance volume as an elasticity, thus obtaining better control over the loudspeaker. This provides a higher quality of the voice reproduction.

When, as stated in claim 8, the acoustic resonance chamber has acoustic openings to the exterior of the chamber, it is possible to make a bass reflex system which has a lower resonance frequency. This means that the system has the ability to expand the frequency range downward with a higher quality of the voice reproduction. At the same time it is possible to eliminate or reduce spikes or peaks in the loudspeaker's frequency response with acoustic openings to the exterior.

When, as stated in claim 9, the dimension of the acoustic resonance chamber, which is completely or partly located within the electromagnetic resonance chamber, is 0.5 to 8 cm3, a further advantageous embodiment of the invention has been achieved.

According to the above-mentioned embodiment, which typically characterises a cellular phone, even minor reductions in volume are important and significant, as the designers of those articles are heavily restricted by the requirement to reduce volume to an "absolute" minimum.

However, it should be noted that the obtained reduction in volume in some devices may of course be much greater within the scope of the invention, if the devices are e.g. fitted with more powerful loudspeakers. In case of an acoustic resonance chamber being of greater volume, an embodiment of the invention will benefit even more from the fact that there are very few constraints, if any, on the design of the resonance chamber.

When, as stated in claim 10, the shared resonance chamber on the inside is reinforced by reinforcement elements or walls dividing the chamber into smaller volumes, it is possible to avoid problems with oscillations in the walls, defining the chamber by using reinforcement elements.

When, as stated in claim 11, the acoustic resonance chamber is completely or partly located within the electromagnetic resonance chamber, wherein said loudspeaker and said acoustic resonance chamber are separated by means of at least one electromagnetic screen, said loudspeaker and said acoustic resonance chamber are acoustically connected through said electromagnetic screen by means of at least one acoustically coupling means, a screening against the electromagnetic fields radiating in a given direction is

obtained. The direction will be from the antenna and toward the loudspeaker and the user's head. Since radiation in this direction gives no or only a weak connection to a receiving antenna due to the user being between the antennas, the efficiency of the antennas will be increased with a screen.

When, as stated in claim 12, said screen is the ground plane of the antenna, it is possible to use the characteristics of a directive antenna such as a directive patch antenna in an advantageous manner.

When, as stated in claim 13, the loudspeaker is coupled with the acoustic resonance chamber by means of at least one acoustic channel passing through said screen, it is possible to dimension the properties, e.g. length, height, diameter or shape, of an acoustic coupling between the loudspeaker and the acoustic resonance chamber in an advantageous manner. This is due to the fact that the acoustic characteristics of the acoustic channel are defined by arbitrary choices instead of the surrounding components of the acoustic coupling providing the designer of the communication device with an active tool when defining the acoustic characteristics of the device.

When, as stated in claim 14, the channel consists of one or more holes in said screen, it is possible to direct the acoustic coupling to the acoustic resonance chamber over the generally shortest possible distance.

When, as stated in claim 15, the number of holes is between 1 and 50, preferably 4 holes, it is possible to

maintain the electromagnetic screening effect by using more holes in the electromagnetic screen but with a smaller diameter. By using more holes, it is also possible to maintain the electromagnetic screening effect by placing the holes in different patterns or no patterns at all.

At the same time, the quality of the acoustic characteristics is not decreased since the total area of holes can be kept unchanged while featuring more holes placed in an acoustically advantageous manner in relation to the acoustic resonance chamber.

When, as stated in claim 16, the diameter of the one or more holes are between 0,5 and 10 mm, preferably 2 mm, it is possible to obtain a further advantageous embodiment of the invention.

When, as stated in claim 18, the acoustic resonance chamber is completely or partly located within the electromagnetic resonance chamber and that the loudspeaker and the acoustic resonance chamber are connected by at least one acoustic coupling means, a multiplicity of opportunities of arranging the loudspeaker inside the housing of the communication device is obtained.

This facilitates a somewhat easier design process of the communication device, which is essential because of the very notable restrictions in regard to the size of the communication device.

Moreover, the fact that the shape of the resonance chamber of a loudspeaker is of very little importance with respect to the desired acoustic performance has more or less been fully exploited.

When, as stated in claim 19, the acoustic coupling means consists of at least one acoustic channel, it is possible to define the acoustic values of acoustic coupling more precisely. This is, of course, also subject to certain limitations associated with the use of acoustic channels e.g. length, diameter and shape of the channel. These limitations are well described within the art of acoustics and more specifically in the design of acoustic channels.

Brief description of the drawings

The above and other objects, features and advantages of the present invention will become more apparent from the detailed description and the accompanying drawings in which:

Fig. 1 is a cross section of a conventional communication device with two separate resonance chambers.

Fig. 2 is a perspective view of a communication device according to the invention.

Fig. 3 is a view of a preferred embodiment of the connection between the loudspeaker and the resonance chamber.

Fig. 4 is a schematic view of the connection between the loudspeaker and the acoustic resonance chamber.

Fig. 5 is a cross view of another preferred embodiment of the connection between the loudspeaker and the acoustic resonance chamber.

Fig. 6 is a cross section of the communication device seen from above.

Fig. 7 is a front view of the housing without the loudspeaker in place.

Description of the invention

Referring to fig. 1, a conventional communication device comprises a housing 8 containing various structural elements, including the necessary elements of a cellular phone such as a display 3, a keyboard 4, a battery (not displayed in fig. 1), a microphone, an antenna 1 and a loudspeaker 2. The elements are mounted on or connected to a printed circuit board (PCB) on which other necessary electronic components are mounted.

The communication device also comprises two volumes used as resonance chambers where the loudspeaker uses a first volume and the antenna uses a second volume. The chambers are separated by the PCB which extends in the entire length of the housing.

The resonance chamber is necessary for the loudspeaker because the front side of the loudspeaker membrane has to be somewhat isolated from the backside of the membrane to

avoid acoustic short-circuiting between the sides of the membrane. The volume inside the resonance chamber determines the lowest possible frequency to be reproduced by the loudspeaker. It also determines the amount of power necessary to obtain a desired sound intensity.

The resonance chamber is necessary for the antenna because it requires a dielectric volume to radiate the radio waves from the active part of the antenna and down to a ground plane.

The distance between the active part of the antenna and the ground plane is at the same time a measurement of the efficiency of the antenna, meaning the greater the distance the higher efficiency up to a certain limit.

Now referring to fig. 2, a communication device according to the invention is displayed. The volume used by the antenna is at same time completely or partly defined by the antenna plane, which acts as walls for the chamber.

The loudspeaker is mounted in an opening in this plane of the antenna and has a direct connection with the volume defined by the antenna.

An antenna of the kind used in the embodiment of the invention has a relatively large volume requirement. To obtain a satisfactory performance by the antenna, the volume has to be in excess of e.g. 13 cm3. Moreover, the loudspeaker requires a certain volume and preferably in excess of 4 cm3. The upper volume limit is determined by the size of the housing and is usually not in excess of

50 cm3 inside the housing which can be utilised as the antenna volume and loudspeaker resonance chamber.

The antenna 1 may preferably be a patch antenna. A dual band patch antenna would be another example of an application within the scope of the invention.

However, it should be noted that according to a further embodiment of the invention, the antenna means may comprise a conventional helix antenna mounted within the housing of the communication device.

Other examples of antennas that may be arranged within the housing of the device are coil and loop antennas.

It is understood that the shape and size of the resonance chamber can be altered from the shape and size displayed in fig. 2. The only thing that restricts the shape and size of the resonance chamber is the housing in which it is incorporated.

In fig. 3, a preferred embodiment of the invention is displayed. To allow the loudspeaker 2 to be placed in other positions than those which are in direct contact with the resonance chamber, an acoustic coupling 10 is inserted between the loudspeaker 2 and the acoustic resonance chamber 9.

It is understood that the shape and size of the acoustic coupling 10 and the acoustic resonance chamber 9 can be altered from the shape and size displayed in fig. 3.

In fig. 4, schematic illustration of the invention is displayed. The loudspeaker 2 and the acoustic resonance chamber 9 are placed separately inside the housing 8 and coupled together with an acoustic coupling 10.

In fig. 5, a detailed embodiment of the invention is illustrated. It shows the loudspeaker 2 and the acoustic resonance chamber 9 being placed separately inside the housing 8 and coupled together with an acoustic coupling 10. The acoustic resonance chamber 9 is located inside the electromagnetic resonance chamber 13 of the antenna 1.

A ground plane 11 separates the loudspeaker 2 and the resonance chamber 9. To establish an acoustic coupling 10 between the loudspeaker and resonance chamber, one or more holes or openings are created in the ground plane 11. The diameter of the holes will normally be between 0,5 and 5 mm, preferably 2 mm, and the number of holes between 1 and 50, preferably 4.

Fig. 6 shows a cross section of the communication device seen from above. The loudspeaker, or transducer 2, is placed at a distance from the acoustic resonance chamber 9 and with the ground plane 11 acting as a screen for electromagnetic fields between the two. The ground plane 11 has a number of holes functioning as an acoustic coupling 10 between the loudspeaker 2 and the acoustic resonance chamber 9.

Fig. 7 shows the front of the housing 8 of the communication device. The loudspeaker, or transducer 2,

has been removed and the acoustic coupling 10 and the ground plane 11 can be seen.

The acoustic coupling can also be one or more channels where the sides are defined by the surrounding components or it can be one or more tubes, pipes or holes. Also it can be combination of the two.

The screen against electromagnetic fields can be the ground plane of the antenna but also a separate screen whose only purpose is screening. Alternatively, it can be a ground plane to be connected with other parts of the communication device.

List

1. Antenna
2. Loudspeaker
3. Display
4. Keyboard
5. Circuit board
6. Upper part of housing
7. Lower part of housing
8. Housing
9. Acoustic resonance chamber
10. Acoustic coupling means
11. Ground plane
12. Acoustic channel or part of an acoustic channel
13. Electromagnetic resonance chamber

CLAIMS

1. Communication device comprising a housing enclosing at least one loudspeaker (2) and at least part of at least one antenna (1) inside the housing (8), said at least one loudspeaker comprising an acoustic resonance chamber (9) and said at least one antenna comprising at least one electromagnetic resonance chamber (13),

characterised in that

the acoustic resonance chamber (9) is completely or partly located within the electromagnetic resonance chamber (13).

2. Communication device according to claim 1, characterised in that the at least one antenna (1) is a directive patch antenna.

3. Communication device according to claim 1 or 2, characterised in that at least one antenna (1) is a dual band antenna.

4. Communication device according to claims 1-3, characterised in that the at least one antenna (1) defines the walls of the acoustic resonance chamber (9) completely or partly.

5. Communication device according to claims 1-4, characterised in that the loudspeaker (2) is coupled with the resonance chamber by means of at least one acoustic channel.

6. Communication device according to claims 1-5, characterised in that at least one antenna (1) is a coil or loop-antenna, preferably a directive coil or loop antenna.

7. Communication device according to claims 1-6, characterised in that the acoustic resonance chamber (9) is a pressure chamber.

8. Communication device according to claims 1-7, characterised in that the acoustic resonance chamber (9) has acoustic openings to the exterior.

9. Communication device according to claims 1-8, characterised in that the dimension of the acoustic resonance chamber (9) completely or partly located within the electromagnetic resonance chamber is 0.5 to 8 cm3.

10. Communication device according to claims 1-9, characterised in that the shared resonance chamber is on the inside being reinforced by reinforcement elements or walls dividing the chamber into smaller volumes.

11. Communication device according to claims 1-6, characterised in that said acoustic resonance chamber (9) is completely or partly located within the electromagnetic resonance chamber (13), wherein said loudspeaker (2) and said acoustic resonance chamber (9) are separated by means of at least one electromagnetic screen (11), said loudspeaker and said acoustic resonance chamber are acoustically connected through said electromagnetic screen by means of at least one acoustically coupling means (10).

12. Communication device according to claim 11, characterised in that said screen is the ground plane (11) of the antenna (1).

13. Communication device according to claim 11, characterised in that the loudspeaker (2) is coupled with the acoustic resonance chamber (9) by means of at least one acoustic channel (10) passing through said screen (11).

14. Communication device according to claim 11, characterised in that the channel consists of one or more holes (10) in said screen (11).

15. Communication device according to claim 14, characterised in that the number of holes is between 1 and 50, preferably 4 holes.

16. Communication device according to claim 15, characterised in that the diameter of the one or more holes is between 0,5 and 5 mm, preferably 2 mm.

17. Communication device according to claims 1-6, characterised in that said acoustic resonance chamber (9) is completely or partly located within the electromagnetic resonance chamber (13) and that the acoustic resonance chamber or at least the main part of the acoustic resonance chamber is located at a distance from said loudspeaker (2).

18. Communication device according to claims 1-6, characterised in that said acoustic resonance chamber (9)

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is completely or partly located within the electromagnetic resonance chamber (13) and that the loudspeaker and the acoustic resonance chamber is connected by at least one acoustic coupling means (10).

19. Communication device according to claim 17 or 18, characterised in that the acoustic coupling means is at least one acoustic channel.

IN THE ABSTRACT:

Please insert the following Abstract on page on a clean sheet after the claims:

--ABSTRACT

The invention relates to a communication device comprising a housing enclosing at least one loudspeaker and at least part of at least one antenna inside the housing. This at least one loudspeaker comprises an acoustic resonance chamber while said at least one antenna comprises at least one electromagnetic resonance chamber. The invention teaches that the acoustic resonance chamber can be located completely or partly within the electromagnetic resonance chamber.--

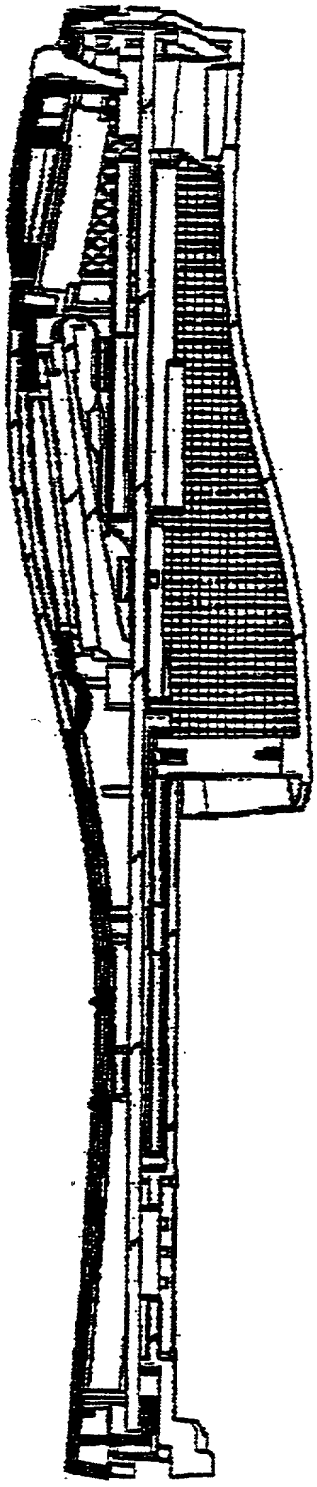


Fig. 1

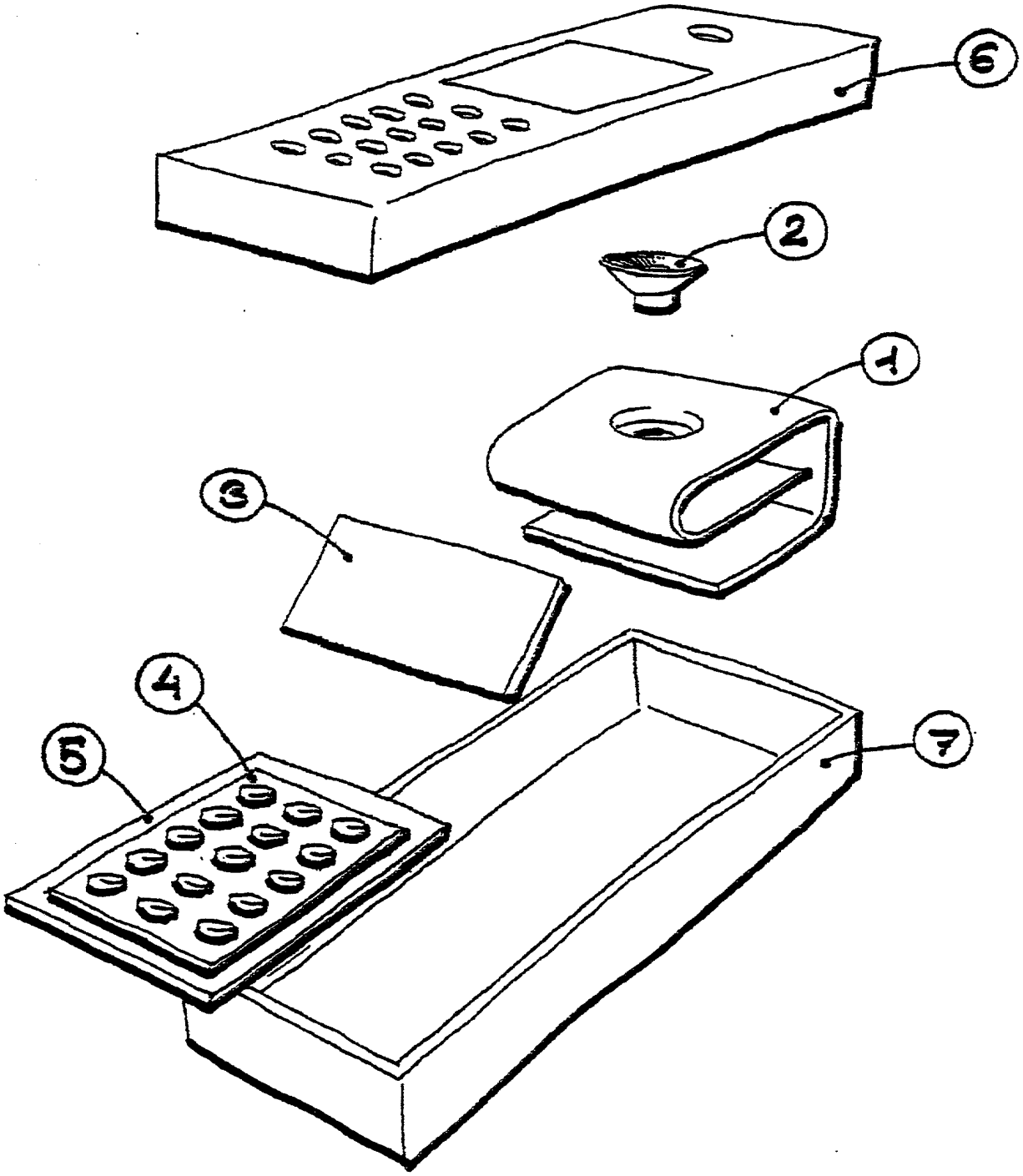


Fig. 2

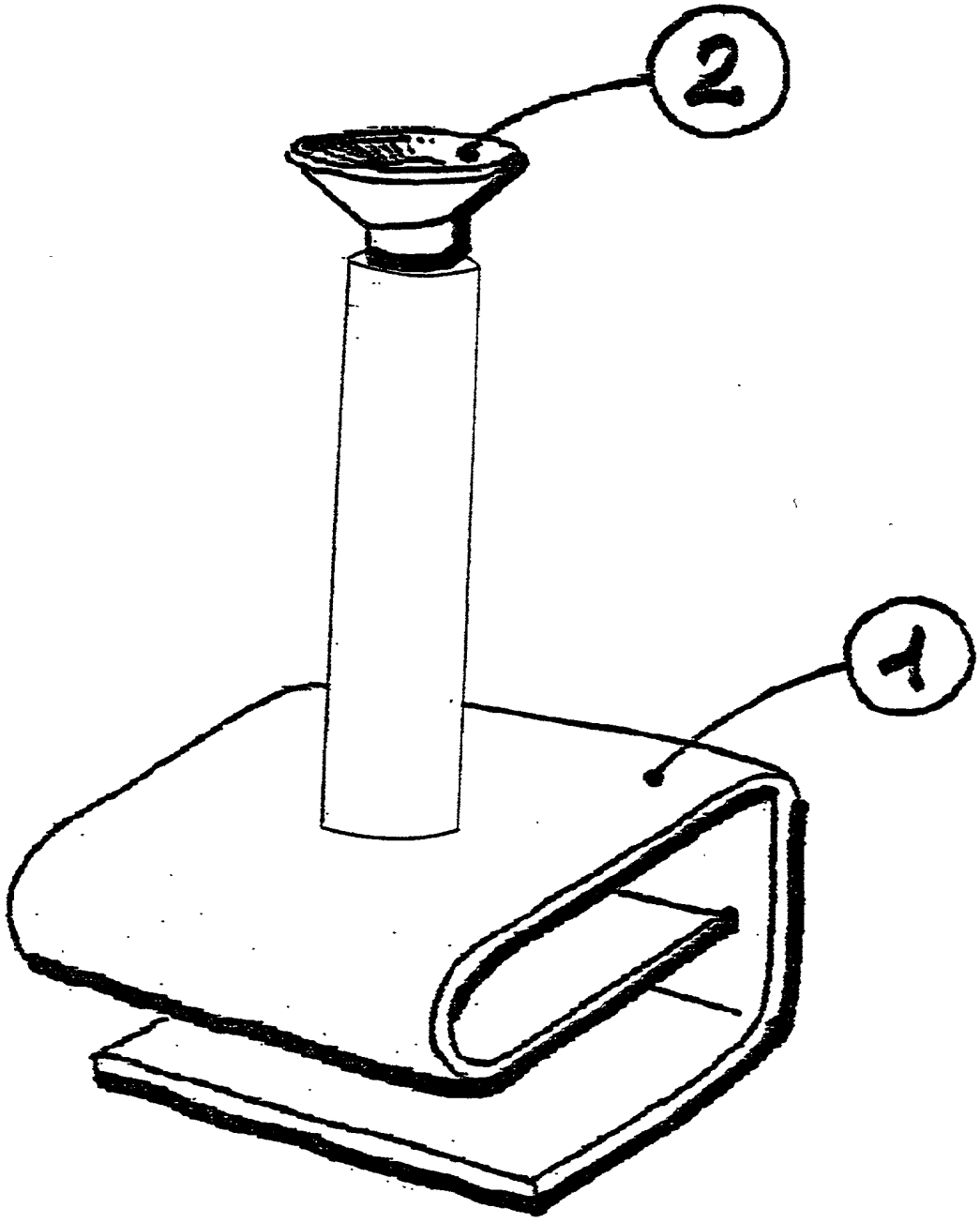


Fig. 3

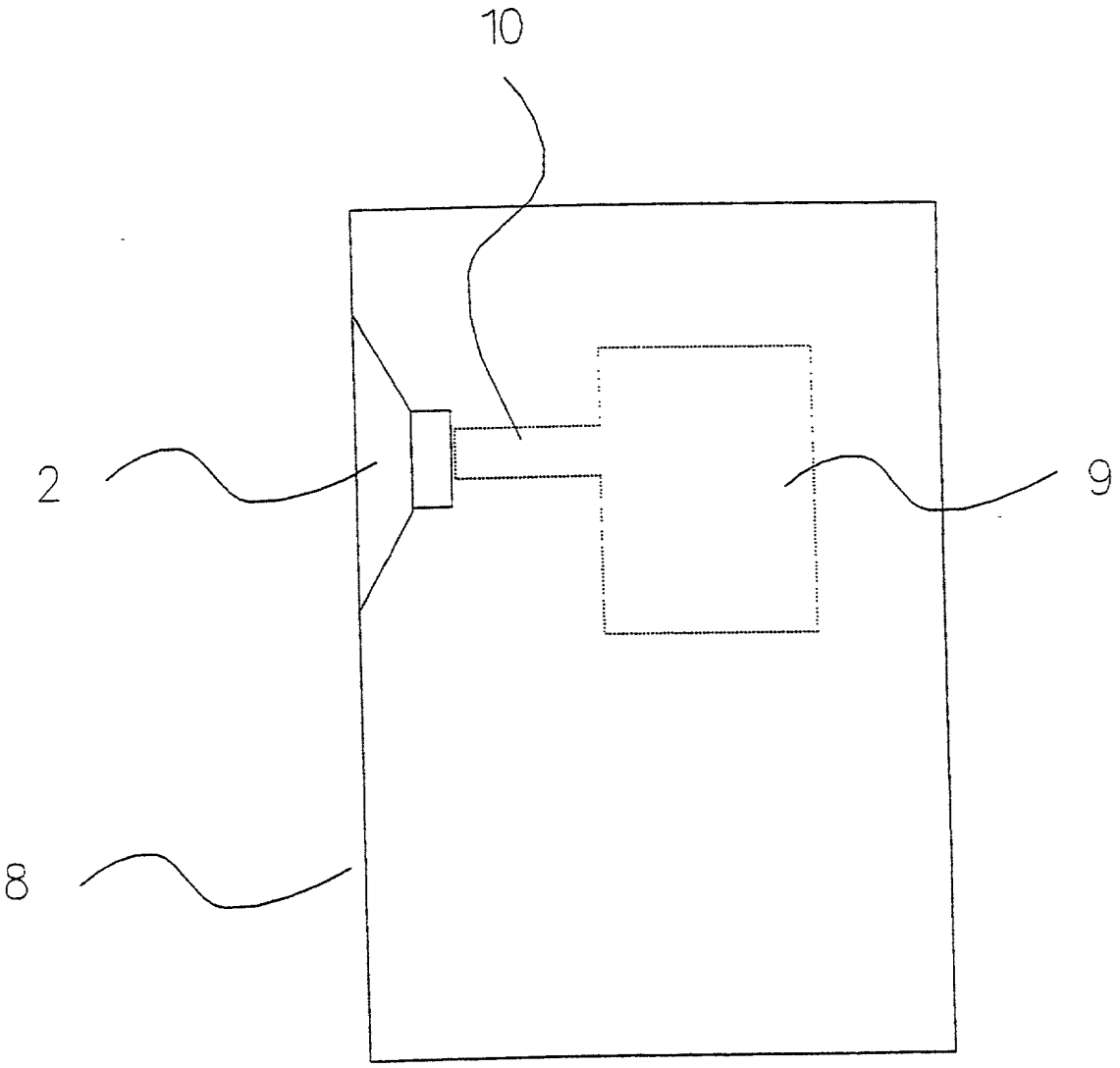


Fig. 4

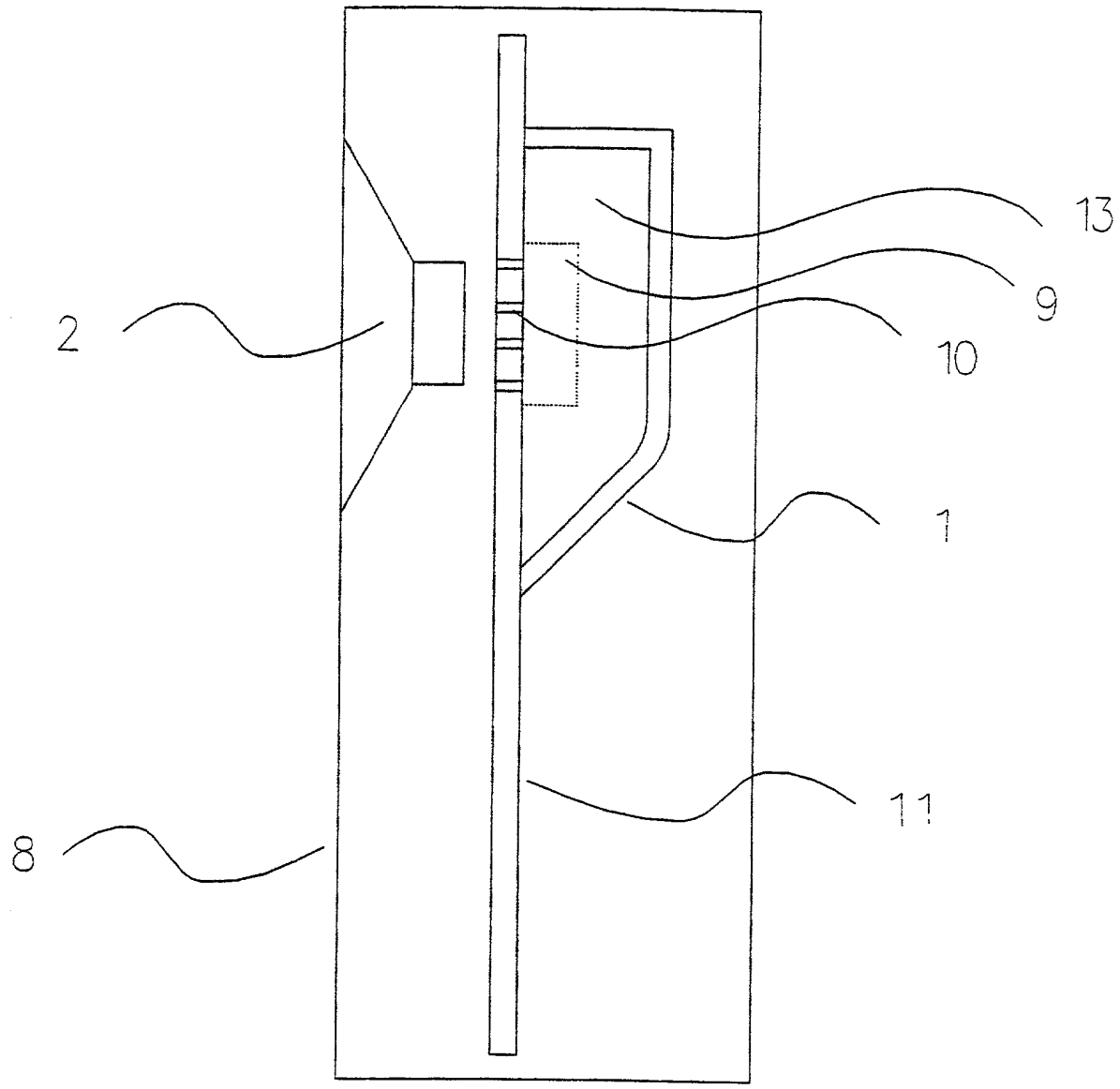


Fig. 5

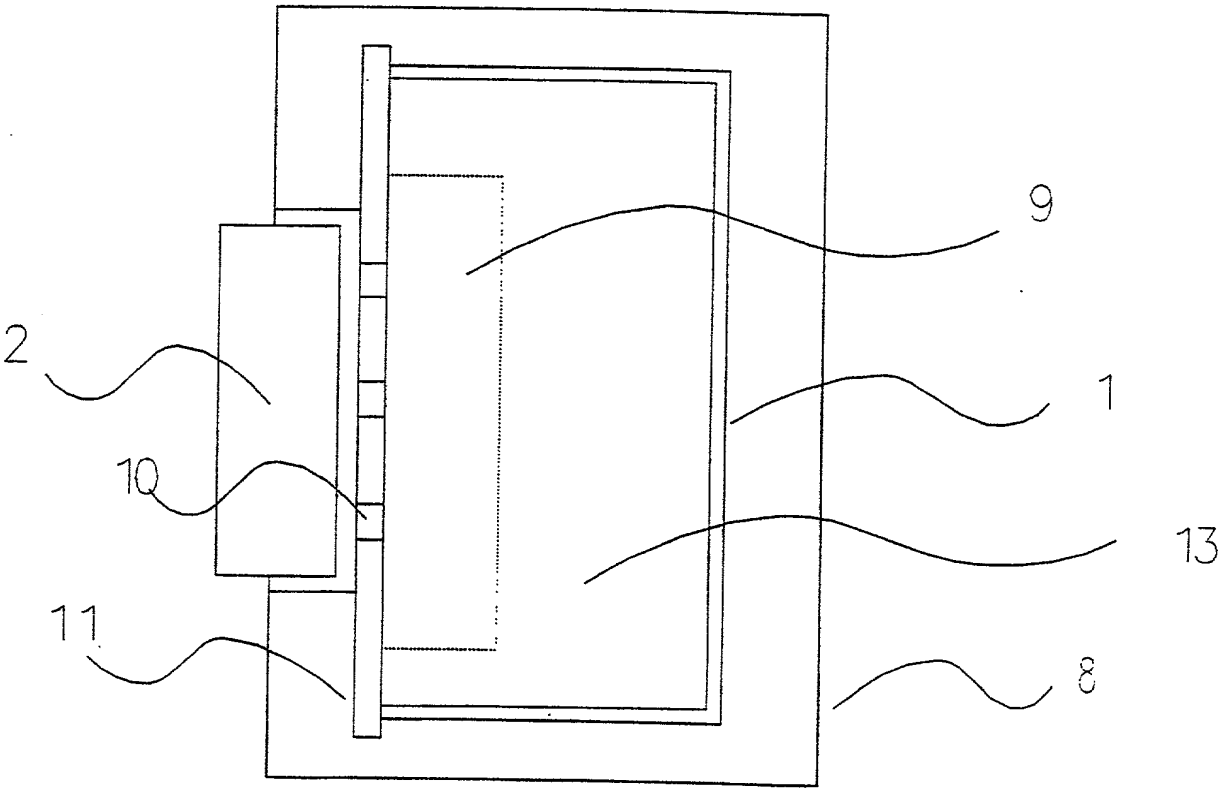


Fig. 6

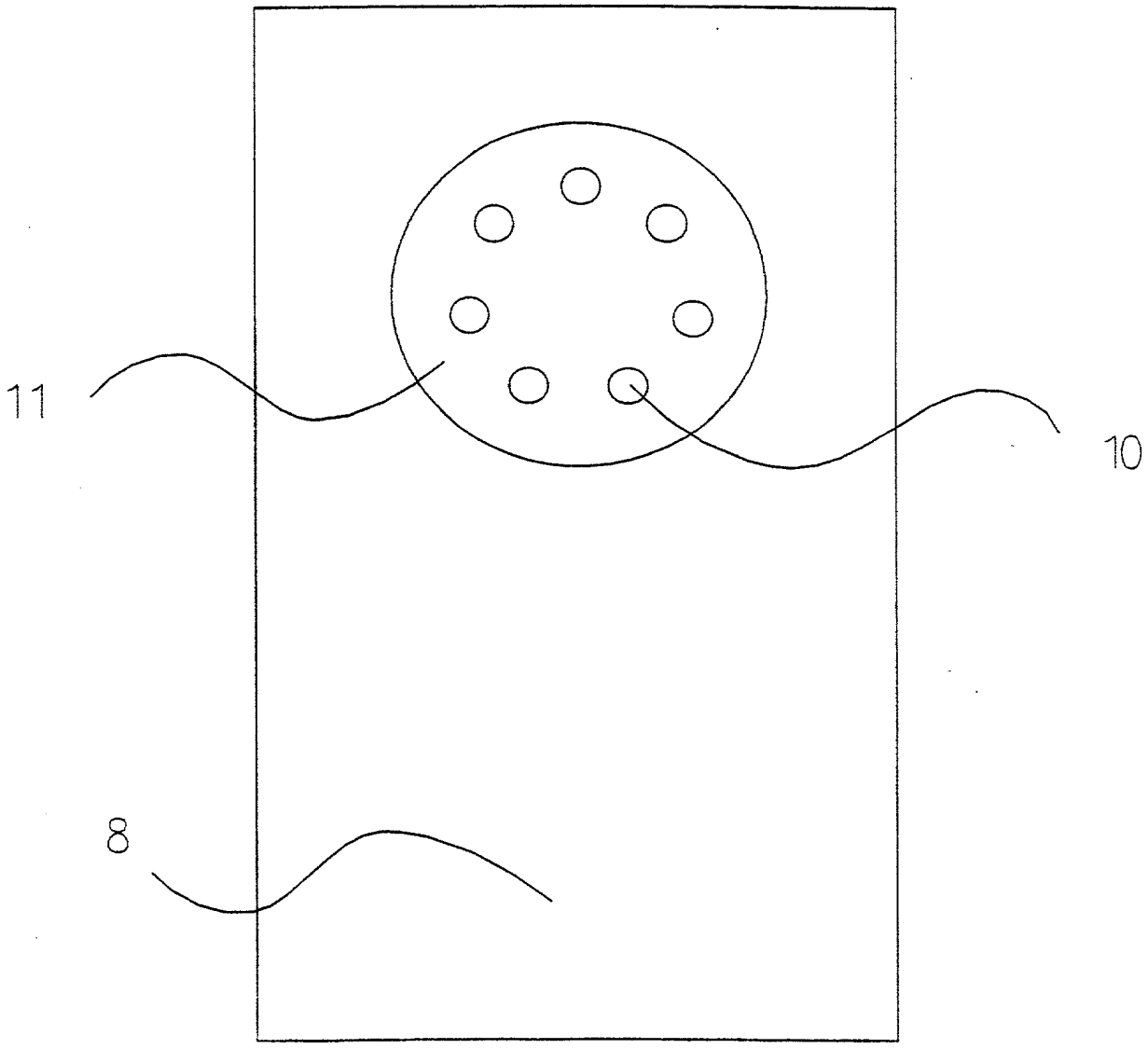
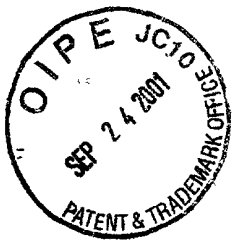


Fig. 7



DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my/our name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled A COMMUNICATION DEVICE the specification of which

(check one)

_____ is attached hereto.

__X__ was filed on June 20, 2001 as

Application Serial No. 09/868,702

and was amended on _____

(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, 1.56(a).

I hereby claim foreign priority benefits under title 35, United States Code 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s).

			Priority Claimed
PA 1998 01700	Denmark	21 December 1998	(Yes) No
(Number)	(Country)	(Day/Month/Year Filed)	
			Yes No
(Number)	(Country)	(Day/Month/Year Filed)	
			Yes No
(Number)	(Country)	(Day/Month/Year Filed)	

I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

PCT/DK99/00719	December 20, 1999	
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

PROVISIONAL APPLICATION NUMBER	FILING DATE
_____	_____
_____	_____
_____	_____

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Michael A. Cantor	-	Registration No. 31,152
Philmore H. Colburn II	-	Registration No. 35,101
Keith J. Murphy	-	Registration No. 33,979
Leah M. Reimer	-	Registration No. 39,341
David A. Fox	-	Registration No. 38,807
William J. Cass	-	Registration No. 41,659
Michael J. Rye	-	Registration No. 34,422
Pamela J. Curbelo	-	Registration No. 34,676
Andrew Ryan	-	Registration No. 43,070
Herbert M. Bedingfield	-	Registration No. 44,530
Timothy J. Olson	-	Registration No. 42,962
Robert J. Feltovic	-	Registration No. 27,710
Christopher C. Boehm	-	Registration No. 41,624
J. Michael Buchanan	-	Registration No. 44,571
George J. Lyman	-	Registration No. 44,884
Karen A. Jalbert	-	Registration No. 39,237
Deborah B. Crenshaw	-	Registration No. 41,689
Leonard E. Heyman	-	Registration No. 40,418
Marisa J. Dubuc	-	Registration No. 46,673
Roberta A. Pelletier	-	Registration No. 46,372
Michael J. Chang	-	Registration No. 46,611
Daniel F. Drexler	-	Registration No. 47,535
James J. Merrick	-	Registration No. 43,801
Troy J. LaMontagne	-	Registration No. 47,239
Charles F. O'Brien	-	Registration No. 47,314
Sean F. Sullivan	-	Registration No. 38,328
Eirc M. Parham	-	Registration No. 45,747
Michael J. Kelly	-	Registration No. 27,910

Send Correspondence to:
55 Griffin South Road
Bloomfield, CT 06002

Direct Telephone Calls To:
Michael A. Cantor
Philmore H. Colburn II
(860) 286-2929

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor: Ion Margvardsen

Inventor's signature: Ion Marg

3/9-2001
Date

Residence: Hadsundvej 56 A, 1. 900 Aalborg, Denmark DK

Citizenship: Denmark

Post Office Address: Hadsundvej 56 A, 1. 900 Aalborg, Denmark

Full name of second joint inventor, if any: Bjarne Hagbart Bjerre

Inventor's signature:

5/9-2001
Date

Residence: Hobrovej 95 9530 Støvring, Denmark DK

Citizenship: Denmark

Post Office Address: Hobrovej 95 9530 Støvring, Denmark